Gesture and motion (encoding of)

Matthieu Evrard, Annie Luciani

Gesture and motion (encoding of)

Matthieu Evrard [ACROE&INPG]
Annie Luciani [ACROE&INPG]

Contributors: Damien Courousse [ACROE&INPG], Nicolas Castagne [ACROE&INPG]

In the context of virtual reality systems, with the development of haptic systems and motion capture systems, and with the need of inter-communication of virtual reality systems through control data, the questions of gesture and motion data, and of their encoding, becomes more and more important.

There is an evident proximity between movement (or motion) and gestures [→ Gesture / movement / action]. The frontier between both is very fuzzy. Both correspond to the moving in space of a part or of the totality of a system. Both refer to the evolution produced by a physical system, whatever it is: human body, real mechanical objects equipped with sensors, virtual objects, motion of a leaf, of a sounding source etc. Differently than actions and symbolic gestures, both motion/gesture data needs to be represented as temporal signals, i.e. a data (position, velocity, etc..) evolving along time.

The only noticeable differences are indeed:

- The fact that movement/motion can be used for any type of system, whereas gesture is usually more reserved to humans.
- The fact that motion is connoted as the result of the performance, i.e. in mediated computer interaction, as an output of an evolving system, whereas gestures correspond more to motions that cause a performance, i.e. the signals used as an input of a system.

Despite these differences, motion/output and gesture/input are two representatives of similar temporal signals, corresponding with an evolving physical system. Thus, the expressions gesture data and motion data could be used indifferently to refer to this sort of gesture-like data, no matter if it is considered as an input or as an output of an evolving systems, possibly a human body.

Focusing on the similarities between gesture and motion rather than on their differences, we are led to identify them as a new and unique type of data. Gesture/motion signals, whatever the way they are produced (objects or human motion, virtual object…), and whatever the way they are considered (as outputs or inputs of evolving systems), do present specific properties that allow distinguishing them among other temporal signals (especially aero-acoustical signals or visual signals). Gesture/motion signals can be distinguished from visual and audio signals by 3 specific features.

Morphological versatility of gesture/motion signal

The morphological versatility of gestures is a first evidence. While images and sounds can be displayed in predefined environments (displays or 3D Caves, with fixed sizes and resolution, stereo or quadraphonic rendering for sounds, etc.), the structure and the morphology of gesture signals are more versatile, depending on the tasks and the manipulated tools. This morphological versatility can be split in two complementary variable characteristics: the geometrical and the structural dimensionalities.

Geometrical dimensionality refers to the dimensionality of the space in which the gesture is evolving. It can be 3D (ex: motion capture situations), 2D (ex: cartoon animation), 1D (ex: when we push a piano or a clarinet key) or a pure scalar space, i.e. 1D non-oriented space. And, for a given geometrical dimensionality, like for instance 1D for the key of a gesture device, the structural dimensionality can vary (from 1 to one hundred key(s), or points, or…, for instance).

Quantitative ranges of gesture/motion signal

In addition to the geometrical and structural dimensionalities, gesture/motion signals present specific quantitative spatial and temporal features.

The frequency bandwidth of gesture/motion signals are positioned specifically on the middle range in the frequency scales of all sensory signals. The visual signal frequency rate is around some Hz, and the acoustical signals frequency rate is some tens KHz. In the middle, gesture/motion signals frequency stands from some Hz to some tens KHz.

Gesture/motion signals also exhibit some specific spatial properties. Whereas acoustical signals are zero-centred deformations of about some millimeters, gesture/motion signals correspond with deformations and displacements that are non-necessarily centred on 0, and that are situated along a spatial range from some millimeters to some meters.

Type of encoded variables of gesture/motion signal

Gesture/motion signal may carry two types of dual variables: extensive variables, such as those derived from spatial information (position, velocity, angle, deformation), and their dual intensive variables (force, torque).

When gestures are used for manipulating object, the correlation between extensive and intensive variables exchanged between the two interacting bodies must be considered, either explicitly as in Newtonian formalism, or implicitly as in the energy formalisms. Hence, differently than in the case of visual or acoustical data, that needs only to encode one type of variables (usually extensive), both extensive and intensive variables are needed for a complete encoding of a gesture interaction.

Formats for the encoding of gesture/motion data

Many formats have been developed to encode motion signals [Menache, 1999] [Maddock, 2000]. Generally those format come from the motion capture community or the video games community, and aims at animating characters. Exemples of such formats are BVA and BVH (Biovision), HTR (Motion Analysis), AOA (Adaptive Optics), ASD (Acclaim and Oxford Metrics), CSM (Character Studio & 3D Studio Max), and C3D (National Institute of Health & Vicon systems). Those formats - especially C3D - are widely used and proved their usability. However, none of them takes into account all the three specific features of gesture/motion signals.

Within the Enactive Interfaces project, a new format called the GMS (for Gesture and Motion Signal) has been proposed as a first attempt for a low-level, minimal and generic format able to encode any motions and gestures [Luciani et al., 2006] [GMS].

References

[GMS] the GMS official internet homepage: http://acroe.imag.fr/gms.

[Luciani et al., 2006] Luciani A. , Evrard M., Castagné N., Couroussé D., Florens J-L, Cadoz C., A Basic Gesture and Motion Format for Virtual Reality Multisensory Applications. Proceedings of the 1st international Conference on Computer Graphics Theory and Applications, ISBN: 972-8865-39-2, Setubal (Portugal), March 2006.

[Menache, 1999] Menache, A., 1999. Understanding Motion Capture for computer animation and video games. Morgan Kauffmann Ed.

[Maddock, 2000] Meredith, Maddock, 2000. Motion capture file formats explained. Departement of Computer Science Technical Report CS-01-11, University of Sheffield.

Related items

Gesture / movement / action
Haptics, haptic devices
Interface, ergotic